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After Action Report - Kazakhstan NSDD July 2015

R. Kips, G. Eppich, K. Knight, C. Fox, A. Belian, P. Gray, B. Canazaro

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Disclaimer

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AFTER ACTION REPORT
NSDD/DOE Kazakhstan July 2015
LLNL-TR-679227

TEAM:

Caterina Fox	Nuclear Smuggling Detection and Deterrence, International Nuclear Forensics Cooperation Sub-Program (DOE/NSDD/INFC NA-213)
Gary Eppich	Lawrence Livermore National Laboratory (LLNL)
Kim Knight	Lawrence Livermore National Laboratory (LLNL)
Ruth Kips	Lawrence Livermore National Laboratory (LLNL)
Anthony Belian	Los Alamos National Laboratory (LANL)
Paul Gray	Pacific Northwest National Laboratory (PNNL)
Bridget Canazaro	Pacific Northwest National Laboratory (PNNL)

DESTINATION: *Almaty - Kazakhstan*

DATES: *17-25 July 2015*

PURPOSE/SUMMARY:
DOE staff traveled to Almaty, Kazakhstan to:

1. Deliver a technical, scenario-based workshop organized by DOE/NSDD on the 'Development of an Analytical Plan in Support of a Nuclear Forensics Investigation'. This workshop was hosted at the Institute of Nuclear Physics (INP) in Almaty, Kazakhstan.
2. Explore future engagements in nuclear forensics.
3. Participate in a DOS-led engagement on nuclear forensics library development.

TRIP REPORT:

- Timeline of our visit (PNNL staff arrived one day earlier for set up)
- Summary of Nuclear Material Inventory Management Working Group Meeting organized by DOS
- Summary of the workshop on analytical plan development
    - Workshop location and background
    - Workshop design and objective
    - Workshop participants
    - Workshop content
    - Workshop outcome
- Summary of the lab tours at INP (attachment F)

Timeline of our visit

Day	Activity
Friday 17 July 2015	Departure US
Saturday 18 July 2015	Arrival Almaty, Kazakhstan
Sunday 19 July 2015	Set up for workshop at INP
Monday 20 July	Set up and DOS meeting
Tuesday 21 July	1st day of workshop
Wednesday 22 July	2nd day of workshop
Thursday 23 July	3rd (last) day of workshop
Friday 24 July	Lab tours and follow-up meetings
Saturday 25 July	Return to US

Nuclear Material Inventory Management Working Group Meeting

On Monday 20 July, Caterina Fox, Ruth Kips and Kim Knight were invited to participate in Kazakhstan's nuclear material inventory management working group meeting coordinated by Alexander Vasilliev as nuclear forensics subject matter experts. The meeting included participants from Kazakhstan's nuclear regulatory agency (CAESC, the Committee on Atomic and Energetic Supervision and Control) and 3 institutes 1. Institute of Nuclear Physics, INP (Almaty), 2. National Nuclear Center, NNC (Kurchatov), and 3. Ulba Metallurgical Plant, UMP (Oskemen). CAESC requested attendance of an MC&A expert, an IT Specialist, and a Physical Security Specialist from each site. The general meeting concerned considerations for creating unified or compatible systems for nuclear material inventory management. NSDD representatives provided an overview of nuclear forensics and presented considerations for developments of inventory management that might be synergistic with future consideration of development of a National Nuclear Forensics Library to support nuclear forensics investigations.

Workshop summary

Workshop Location and Background

The workshop was delivered at the Institute of Nuclear Physics (INP) of the Republic of Kazakhstan in Almaty. INP is part of the National Nuclear Center of the Republic of Kazakhstan under the Ministry of Energy. The Institute was established in 1957 and houses a 6MW light water-moderated VVR research reactor. INP's primary function is to conduct research in the field of nuclear and solid-state physics, as well as nuclear technology development, reactor safety research, radiation materials studies, and the monitoring of environmental radiation levels in Kazakhstan (including the Semipalatinsk and other sites in Western Kazakhstan). INP also recently made major investments in its isotope production facilities (including a new cyclotron and several hot cells) for medical and industrial use. Tours of the environmental and nuclear materials research laboratory spaces, the VVR reactor, and the new isotope production facility (under preliminary testing and just starting experimental operations) were provided to the NSDD delegation. More details on INP's facilities can be found in the lab tour section.

The workshop for this visit was held at INP, which is one of the prime laboratories in Kazakhstan supporting the analysis of nuclear materials found outside of regulatory control. Under the auspices of the 2006 Joint Communiqué on counter trafficking of nuclear and radioactive material, DOE/NSDD is cooperating with INP on strengthening Kazakhstan's nuclear forensics capabilities. In September 2014, Kazakhstan accepted a proposal for collaboration between NNSA and INP in the area of technical nuclear forensics. As the first step of the cooperation plan, three technical experts from INP attended the IAEA-NNSA International Training Course on Nuclear Forensics Methodologies, held at PNNL, in May 2015. As a continuation, a short technical course detailing considerations for Analytical Plan Development for technical response to a nuclear forensics investigation was created by SME's at LLNL, LANL and PNNL based on participation in an international nuclear forensics exercise hosted by the International Technical Working Group (ITWG), the 2014 CMX-4 exercise.

The US DOE/NNSA has also been working with Kazakhstan to develop a Nuclear Security Training Center (NSTC) at INP to improve indigenous security and safeguards training capabilities for all nuclear facilities in Kazakhstan. DOS, DOE and DOD are collaborating with Kazakhstan to develop a counter nuclear smuggling curriculum at the NSTC and other related nuclear security training.

Workshop Design and Objective

During this 3-day scenario-based workshop, representatives from DOE/NSDD and laboratory experts from LLNL, LANL and PNNL highlighted the role and considerations of the analytical laboratory in supporting a nuclear forensics investigation. The team was composed of SME's with various complementary technical backgrounds, extensive hands-on experience in nuclear forensics and radiological and nuclear detection, as well as many years of experience as an instructor for international audiences (see bios in Attachment E). The course covered many technical presentations on analytical methods and instrumentation, but also discussed incident response and crime scene management, as well as other nuclear forensics concepts such as confidence in conclusions (see agenda in Attachment A).

Through presentations, group exercises and discussions based on an actual international nuclear forensics Collaborative Materials Exercise (CMX-4), organized by the ITWG in 2014, the process of analytical plan development, focusing on the sequencing of techniques for analyzing nuclear forensic evidence, was illustrated. Course materials were prepared in English and translated to Russian, and delivered in English with Russian speaking interpreters. Participant discussion was encouraged throughout the course. These were the some of the workshop's objectives/take away messages:

- Provide an overview of the different analytical techniques that can be applied in a technical nuclear forensics investigation
- Highlight the importance of documenting sample receipt, chain-of-custody and avoiding cross contamination
- Emphasize the iterative process of the analytical plan development in the context of a nuclear forensics investigation

- Demonstrate how the development of an analytical plan is driven by the questions from the authorities/law enforcement
- Highlight the importance of clear communication of the analysis results and reporting confidence in conclusions
- Demonstrate how a nuclear forensics capability can/should be built upon existing capabilities/expertise

The scenario-based workshop utilized the "problem-based learning" approach to allow workshop participants to work, step-by-step, through an active nuclear forensics investigation from the point-of-view of the laboratory analyst. Problem-based learning draws on the practice of scientific inquiry in which participants are asked to answer a question or series of questions in an open-ended fashion. Rather than learning nuclear forensics concepts by rote, the participants develop their own answers and arrive at certain desired conclusions by working through a process. Participants learned how to develop and revise an analytical plan, sequence techniques for analyzing nuclear forensic evidence, interpret results, assess confidence in conclusions, and report findings in response to law enforcement questions.

This workshop also provided context and background to prepare INP for the next step in the NNSA/INP collaboration, which is a joint INP/LLNL comparative sample analysis of a commercially available uranium ore concentrate reference material (CUP-2, Natural Resources Canada), planned for early FY16.

Workshop Participants

The workshop participants list is attached. There were 20 participants in total, including 18 participants from INP that had a variety of technical backgrounds, including but not limited to: gamma spectrometry, alpha spectrometry, mass spectrometry, reactor operation/nuclear engineering, and laboratory management (3 lab managers participated, who also attended the IAEA-NNSA training course at PNNL, and Acting Director Petr Chakrov observed several sessions). We also had 2 participants from the nuclear regulatory agency, the Committee on Atomic and Energetic Supervision and Control (CAESC), one of whom was the Deputy Director for Nuclear Security and Kazakhstan's lead for nuclear forensics. The other was a licensing expert and the Committee's lead for nuclear safety.

For the workshop exercises, the participants were divided into three groups of seven participants each, spreading expertise among the groups to further encourage discussion.

Workshop Content

Participants were provided with the original CMX-4 scenario (detection of three suspect materials), and this theme and the related injects were run through the entire workshop. Data injects were based on LLNL's CMX-4 report. Lab experts provided presentations on general nuclear forensics concepts (including the ITWG Model Action Plan), a description of key nuclear forensics techniques, and best practices on confidence in conclusions.

In four sequenced breakout-group discussions, participants were asked to evaluate data derived from short-term, mid-term, and long-term analyses that were performed as part of the fictitious laboratory's analytical plan. After each discussion, participants answered a series of questions to revise their analytical plan and respond to law enforcement questions.

At the end of the workshop, participant groups were asked to report their findings to law enforcement. They were also then provided with a summary version of LLNL's CMX-4 report, which was discussed in the break out groups and sparked considerable interest from the participants regarding conclusions and other possible analytical plan sequences. The agenda of the workshop is attached.

Workshop Outcome

- During the workshop, participants successfully participated in a group discussion regarding the CMX-4 samples, using the data injects, which:
  1) aided the laboratory's preparedness to perform a joint material collaboration (using CUP-2) in the next step of our bilateral nuclear forensics cooperation (see below), and
  2) advanced INP's readiness to participate in the next ITWG collaborative materials exercise if they would be willing to do so. CAESC is actively encouraging INP to participate, and this would meet a major USG objective under the US-GOK Counter Nuclear Smuggling Joint Action Plan.
- Participants became aware of how to develop, revise, and communicate an analytical plan in support of a nuclear forensics investigation, which involves the sequencing of short-term, mid-term, and longer-term analytical techniques. They also experienced the importance of chain-of-custody, and the need to adhere to the boundaries of the investigation by specifically answering questions posed by law enforcement.
- Participants independently identified the utility of having a national nuclear forensics library (NNFL) or database to support nuclear forensics investigations.
- CAESC provided high accolades for our workshop to Mr. Marat Shaldybaev, our lead USG point of contact for nuclear security, who expressed an interest in exercising nuclear forensics capabilities with other capabilities involved in responding to nuclear security incidents. (Specifically, Mr. Shaldybaev expressed an interest in exercising nuclear forensics together with law enforcement capabilities.)

KEY CONTACTS:

Name	Title/Contact Info
Chakrov, Petr	Acting General Director of the Institute for Nuclear Physics/ chakrov@inp.kz, +7-727-386-6801
Gluchshenko, Viktor	Head of Center of Complex Ecological Investigations, Institute for Nuclear Physics/ vik@inp.kz, +7-727-386-6843
Marat Shaldybaev	Head of the Nuclear Security Division, Committee on Atomic and Energetic Supervision and Control (CAESC)

KEY ISSUES AND OBSERVATIONS:

- Despite differences in culture, we achieved very active participation from all workshop participants, both during the presentations and the group exercises (break-out sessions):
  - The participants were deeply engaged in the process of carrying out the spectrum of nuclear forensics activities as laboratory experts, and they

performed impressively in interpreting the actual data sets and reporting their results.
    - Participants responded well to the SME presenters, and course content was well tailored to the specific capabilities and interests of INP thanks to previous engagements and visits. Future offerings would be well served to establish the general interests and capabilities of the participants to achieve similar results.
    - Participants and facilitators engaged in lively and fruitful discussion and brought a body of knowledge, viewpoints, and experiences to the discussion, offering insights that went above and beyond the facilitators' guide for the breakout sessions. Facilitators offered additional best practices and specific examples from published nuclear forensics case studies to reinforce key themes.
- The workshop received glowing accolades from the participants and lab management (including Acting Lab Director Petr Chakrov): the design of the scenario-workshop was interactive, innovative, and very effective in illustrating the process of analytical plan development for the technical experts at INP.
- INP expressed its interest in using some of the workshop materials for its future National Security Training Center.

NEXT STEPS:
The next step will be for NSDD/LLNL to work with INP on:

- Update workshop materials using feedback from both participants and facilitators.
- A sample comparison exercise: since the timely export of nuclear samples from Kazakhstan is presently logistically challenging, LLNL proposed to provide a well-characterized UOC material (CUP-2) for initial nuclear forensics analysis and subsequent data exchange. LLNL and INP technical staff will exercise and develop current capabilities and work with INP to identify additional training needs.
- 2-week hands-on training at LLNL, with an additional 2-3 days at LANL (planned for FY17) with select technical experts from INP. The exchange will cover the techniques and capabilities involved in analysis of uranium materials for trace elements by ICP-MS, optical and electron microscopy, gamma spectrometry, XRD/XRF and related techniques to provide training in best practices and address specific needs in nuclear forensics.

IMPACT ON COUNTRY PLANNING:

- The adaptation of the CMX-4 scenario and data injects, the well-crafted discussion questions, excellent facilitation of the nuclear forensics SMEs, as well as the event coordination support made this workshop an important success that will advance NSDD's goal of strengthening nuclear forensics capacity in Kazakhstan.

- DOE/NNSA’s program will proceed according to the proposal on technical nuclear forensics cooperation that was accepted by the Kazakhstanis during the official government-to-government Counter Nuclear Smuggling Implementation Review on November 8-9, 2014.

- This workshop will support NSDD in other bilateral engagements as well, and the next offering is projected to be in Algeria (COMENA) in January 2016, where prior engagements have helped establish the methods and expertise present. The course will be slightly modified to better fit this context.

Additional Information and Attachments:

A. Workshop agenda
B. Workshop participants list
C. Workshop photos
D. Thank you letter from INP's Acting General Director, Petr Chakrov
E. Workshop facilitators' bios
F. INP lab tour (notes by G. Eppich – LLNL)
G. Agenda DOS Nuclear Material Inventory Management Working Group Meeting

Attachment A: Workshop agenda

NSDD Workshop Kazakhstan: Development of an Analytical Plan in Support of a Nuclear Forensics Investigation

Tuesday 21 July 2015

8:30	Start of the meeting + welcome by Dr. Petr Chakrov (INP)
8:45	Introductions (workshop facilitators + participants)
9:15	#1 NSDD-Forensics Program Overview
9:45	#2 Presentation on Guidelines and Concepts for Analytical Plan Development
10:30	Break
10:45	#3 Presentation on Incident Response and Radiochemical Crime Scene Management
11:30	#4 Exercise on analytical plan development: Introduction to the Exercises
12:15	Lunch
13:15	#5 Exercise Analytical Plan Development Part #1: Incident Response and Radiological Crime Scene Management
14:15	Group discussion on outcome Exercise Part #1
14:45	Break
15:00	#6 Presentation on Nuclear Forensics Laboratory Capability
16:00	#7 Presentation on Case Studies of Nuclear Forensic Analyses
16:45	End of workshop day 1

Wednesday 22 July 2015

8:30	Start of second day of the workshop - Recap/review
9:00	#8 Presentation on Sample Receipt and Short-term Measurements
9:45	#9 Exercise Analytical Plan Development Part#2: Sample Receipt and Short-Term Measurements
10:45	Break
11:00	Group Discussion Exercise Part 2
11:30	#10 Presentation Short-term Radiological Measurements – Gamma- and Alpha Spectroscopy
12:15	Lunch
13:15	#11 Presentation on Mid-term Chemical Measurements: X-ray Diffraction and X-ray Fluorescence
14:00	#12 Presentation on Mid-term Chemical Measurements: Elemental Concentration Measurements by ICP-MS
15:00	Break
15:15	#13 Presentation on Mid-term Chemical Measurements: Isotope Ratio Measurements by ICP-MS and TIMS
16:15	End of workshop day 2

Thursday 23 July 2015

8:30	Start of last day of the workshop – recap/review previous days
9:00	#14 Presentation on Longer-term Chemical Measurements: U assay Techniques by IDPMS and Davies-Gray Titration
10:00	#15 Exercise Analytical Plan Development Part#3: Longer-term Measurements
11:15	Break
11:30	Group Discussion Exercise Part 3
12:15	Lunch
13:15	#16 Presentation on Confidence in Measurement Conclusions
14:00	#17 Conclusion Activity: Analytical Plan Development Part#4: Communication of Final Results
14:45	Break
15:00	Group Discussion on Exercise Part#4: Communication of Final Results Distribution of LLNL CMX-4 report
15:45	Graduation ceremony and feedback from participants
16:45	End of workshop

Attachment B: Workshop participants list

№	Full name	Position	Role in the expert investigations
1	Pustovoy Alexandr	Advisor of General Director, INP	Coordination of expert forensics activities in INP, preparation of expert forensics conclusions
2	Gluchshenko Viktor	Head of Center of Complex Ecological Research in INP	Coordination of analytical research activities during expert forensics activities, preparation of materials for expert forensics conclusions
3	Sidorenko Sergey	Head of Radiation Safety Department in INP	Organization and performance of primary inspection, dosimetric and radiometric measurements during the special investigations. Providing of radiation safety.
4	Nabi Askar	Employee of National Safety Committee, INP	
5	Sydykov S.A.	Employee of National Safety Committee, INP	
6	Abdullaev A.A.	Employee of National Safety Committee, INP	
7	Kim Dmitriy	Deputy Chief of Radiation Safety Department, INP	Organization and performance of primary inspection, dosimetric and radiometric measurements during special investigations. Providing of radiation safety.
8	Sidorenko Konstantin	Head of Radiation Control Department, INP	Organization and performance of primary inspection, dosimetric and radiometric measurements during special investigations. Providing of radiation safety.
9	Kharkin Pavel	Production Chief Specialist, Center of Complex Ecological Research, INP	Organization and performance of laboratory investigations
10	Poznyak Viktor	Senior staff scientist, INP	Organization and performance of radionuclide content study
11	Bychenko Alexandr	Head of Elemental Analysis group, INP	Study of elemental, trace elemental and isotope composition by ICP-MS method
12	Zheltov Dmitriy	Senior staff scientist, INP	Study of elemental and trace elemental composition by ICP-MS method
13	Edomskaya Mariya	Junior staff scientist, INP	Study of elemental and trace elemental composition by ICP-MS method
14	Matiyenko Lyudmila	Head of radiochemistry group, INP	Radiochemical investigations
15	Gluchshenko Galina	Head of spectrometry group, INP	Organization and performance of radionuclide composition study
16	Baigurzhin Aidos	Engineer, INP	Dosimetric, radiometric and gamma-spectrometric investigations
17	Abdurahmanov Zhasulan	Engineer, INP	Dosimetric, radiometric and gamma-spectrometric investigations

18	Nurtazin Ernat	Head of Individual Dosimetric Control division, INP	Primary inspection, dosimetric and radiometric measurements during special investigations. Providing of radiation safety.
19	Tulegenov Murat	Deputy Director for Nuclear Security, Committee on Atomic and Energetic Supervision and Control (CAESC)	Kazakhstan's lead for nuclear forensics
20	Azmaganbetov Bauyrzhan	Licensing expert, Committee on Atomic and Energetic Supervision and Control (CAESC)	CAESC lead for nuclear safety

Attachment C: Workshop photos

Attachment D: Thank you letter – P. Chakrov, Acting General Director INP

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25.07.2015 № 34-02-16/1024

На _____ от _____

Caterina D. Fox

Nuclear Smuggling Detection and Deterrence Program

U.S. Department of Energy / National Nuclear Security Administration

Dear Ms. Fox,

Please accept our congratulations on very successful completion of the Workshop on Development of an Analytical Plan in Support of a Nuclear Forensics Investigation, held in Almaty on July 20-24, 2015.

Indeed, the results exceed our expectations. INP technical experts involved in examinations of nuclear and radioactive materials with various analytical techniques received much wider and systematic view of nuclear forensics. The workshop format and content were perfectly designed for this kind of audience. Active engagement of all participants in the group discussion exercises which accompanied all lectures gave them not only new knowledge of best international practices but also valuable practical skills in methodology and procedures of nuclear forensic examinations.

Special thanks to workshop lecturers and facilitators from Lawrence Livermore National Laboratory, Pacific Northwest National Laboratory and Los Alamos National Laboratory, to you and US Department of Energy who made it possible.

We really appreciate your and your colleagues' efforts and the time all of you spent for designing, preparation and conducting of this workshop which made a significant practical input in development of sustainable nuclear forensics capability in Kazakhstan.

Sincerely yours,

Petr Chakrov
Acting General Director
Institute of Nuclear Physics, Almaty, Kazakhstan
July 25, 2015

Attachment E: Workshop facilitators' bios

Caterina Fox

Caterina Fox joined the U.S. Department of Energy/National Nuclear Security Administration's (DOE/NNSA's) Office of Global Material Security (GMS) in 2013. Through her work with GMS's Nuclear Smuggling Detection and Deterrence Program, she supports international cooperation on nuclear forensics as part of a broader NNSA effort to strengthen global nuclear security.

From 2011-2013, Fox served as a policy analyst at the U.S. Africa Command. Previously, from 2010-2011, she worked for DOE/NNSA's Office of Nonproliferation and International Security as nonproliferation graduate fellow. Before that, from 2007-2010, she was a staff member on the Committee on Armed Services of the U.S. House of Representatives. From 2004-2007, she served as a research assistant on a range of nuclear nonproliferation issues at the Carnegie Endowment for International Peace, a Washington, D.C.-based think tank.

Fox completed her Master's Degree with Distinction at the U.S. Naval War College in national security and strategic studies in 2011. In 2004, she completed her undergraduate studies at the University of Virginia with a double major in Foreign Affairs and Italian.

Ruth Kips

Dr. Ruth Kips is a staff scientist at Lawrence Livermore National Laboratory. Ruth has a Master's Degree in Nuclear Engineering and obtained her Ph.D. in Chemistry from the University of Antwerp in Belgium. Ruth's doctoral research focused on the production and characterization of uranium reference particles for nuclear safeguards and was carried out at the Institute for Reference Materials and Measurements (IRMM) of the European Commission's Joint Research Centre (EC-JRC).

In 2008, Ruth joined LLNL as a postdoctoral staff member, where she specialized in the characterization of uranium oxyfluoride particles from UF6 hydrolysis using nanoscale secondary ion mass spectrometry (NanoSIMS). To gain more practical experience in environmental sampling and the analysis of uranium particles, she joined the International Atomic Energy Agency (IAEA) in Vienna, Austria in 2012 as a nuclear safeguards inspector in Operations B.

Ruth returned to LLNL in August of 2014, where she is responsible for international nuclear forensics engagements and training, as well as the microanalysis of nuclear materials for nuclear forensics, nuclear safeguards and the environmental transport of actinides.

Paul Gray

For the last sixteen years, Mr. Gray has worked at Pacific Northwest National Laboratory (PNNL) as both a scientist and project manager. During that time, he has supported the domestic Radiation Portal Monitor (RPM) project for the US Department of Homeland Security (DHS) deploying fixed and mobile radiation detection equipment to US seaports and the US Department of Energy's (DOE) Nuclear Smuggling, Detection and Deterrence (NSDD, formerly known as Second Line of Defense (SLD) program.

In his current role with NSDD, Paul deploys mobile radiation detection equipment to partner countries and trains foreign police, border guard and customs' officers on the use of that equipment. Additionally, Mr. Gray supports the NSDD Workshop and Exercise program as a subject matter expert assisting partner countries in planning, conducting and evaluating radiological and nuclear detection exercises. Paul spent thirty years in the US Army as an operations officer and chemical, biological, radiological and nuclear (CBRN) specialist working primarily on CBRN reconnaissance and decontamination in the later role. He is a certified US Army Small Group and DOE instructor.

Gary Eppich

Gary Eppich received his Bachelor's Degree in geology from Colgate University in 2006 and his master's degree in geology from University of California – Davis in 2010. He joined Lawrence Livermore National Laboratory in 2010 and is currently a staff scientist in the Environmental Radiochemistry Group of the Nuclear and Chemical Sciences Division.

He works in mass spectrometry on a wide variety of environmental and nuclear forensics projects, and is the custodian of the B151 X-ray fluorescence facility. His research interests include volcanology, actinide radiochronometry, and environmental chemistry.

Kim Knight

Kim Knight is a staff scientist at Lawrence Livermore National Laboratory focused on nuclear forensic research through analysis of nuclear and associated materials for clues about material origins. A geochemist by training, she was and remains endlessly fascinated with radioactive materials. She is presently involved in the development of new techniques and methods which can be applied to improve interpretation of nuclear materials, including several international collaborative technical efforts. She has been involved in the design and delivery of numerous training courses in technical nuclear forensics, as well as the development and revision of international guidelines as a participant in IAEA consultancies and workshops.

Dr. Knight received her Ph.D. from the University of California, Berkeley in 2006, working as a post-doctoral researcher at The University of Chicago and Argonne National Laboratory, prior to joining LLNL in 2008.

Anthony Belian

Dr. Belian has been a staff scientist in the Safeguards Science and Technology group at Los Alamos National Laboratory for 15 years. He specializes in the development of neutron and gamma-ray based Non-Destructive Assay (NDA) technology in support of international safeguards. He spent 5 years as an application specialist at the IAEA providing expert level support to Operations on NDA related issues.

Attachment F: INP LAB TOUR (notes by G. Eppich)

CENTER OF COMPLEX ECOLOGICAL STUDIES (founded in 1999)
Head Scientist: Viktor Gluchshenko

- Low-level elemental and isotopic analyses
- ~5 laboratories, ~100 workers
- Used for environmental analyses
- High-throughput lab (~10,000 samples handled annually)

Some types of samples handled in this laboratory facility

- Environmental samples related to oil storage and extraction (presumably in western Kazakhstan, Caspian Sea)
- Contaminated radiological samples from Semipalatinsk test site
- Samples related to the uranium mining industry

Laboratory capabilities

- Sample storage area
    - There was flooding in the main storage area, so a temporary area is being used
    - Soil samples are stored in plastic bags – *not a robust way to store samples, but it appears that this is how they were collected*

- High-level sample receipt area
    - This is where nuclear forensics samples would be initially handled
    - Series of metal fume hoods
        - *Could not get a sense of the level of cleanliness of the interior hood/ducts, but this area is older and does not appear to be heavily utilized for research and analyses at present.*
    - May need to refurbish to prevent cross-contamination between nuclear forensics samples and environmental samples

- Furnace room
    - Furnaces used for drying and ashing biological samples
    - *Cleanliness of furnaces might be an issue – it is relatively easy to contaminate samples with a dirty furnace*

- Chemistry laboratories
    - Water purification available for trace element analyses
        - *Not sure if the reagent water is up to the 18.2 MΩ resistivity standard – this may affect ability to measure trace elements in nuclear forensic samples*
    - Glass beakers frequently used for environmental samples
        - *Would want to use trace metal grade laboratory disposables for nuclear forensic samples*
        - *Can purchase clean, or can clean using trace-grade acids*
    - Chemical separations generally performed using porous filter systems rather then resins
    - Acid distillation performed on-site

        - *Should store these distilled acids in Teflon bottles, if not already doing so*
        - *Squirt bottles typically used for aliquotting acids to samples*
    - Segregation of radioactive and non-radioactive samples typically performed in INP chemistry laboratories

Instrumental capabilities

- Inductively coupled plasma – mass spectrometry (ICP-MS)
    - Perkin-Elmer ELAN 9000 ICP-MS
    - Analytical technique used to determine the concentration of major and trace elements of samples in the liquid state at up to ultra-trace concentrations
    - Sample is ionized and accelerated to a magnet, where the ions are separated on the basis of mass-to-charge ratio, and detected
    - Quadrupole lens is used to perform the mass-to-charge separation
    - Typical samples include oil and gas environmental samples from Caspian Sea oil extraction
    - Biological and radioecological samples also routinely analyzed
    - Concentration standards for calibration purchased from Inorganic Ventures
    - External Russian/Kazakh QC standards used
    - Used for trace element analyses at INP, for a variety of sample types
    - *Potential complication: nuclear forensics samples may require dedicated sample introduction system in order to avoid compromising ongoing environmental chemistry work*

- Inductively coupled plasma – optical emission spectroscopy (ICP-OES)
    - Perkin-Elmer Optima 8000 ICP-OES
    - Analytical technique used to determine the concentration of major and trace elements of samples in the liquid state
    - Ionization of the sample produces electromagnetic radiation – wavelengths are characteristic of the elements present in the sample, and the intensity of the radiations are proportional to elemental concentration
    - Used primarily for uranium concentration measurements

- Gamma spectrometry
    - At least four gamma spectrometers available
    - Detector types:
        - Well detectors
        - Planar detectors
        - Coaxial detectors
    - Additional gamma spectrometers available in the high-level radioanalytical facility

- Liquid scintillation counting
    - Used for alpha and beta particle detection
    - Tri-Carb 3100TR low activity liquid scintillation analyzer

- Alpha spectrometry
    - Canberra and Ortec alpha ensembles used

    - Primarily used for measurements of radioecological samples
    - Membrane filtration for chemical separation/sample preparation
    - No electroplating performed
    - Located in both the low-level and high-level radioanalytical facilities
    - *This may be the best method for INP to perform high-precision U isotopic analyses with the existing analytical capabilities*

- X-ray fluorescence (XRF)
    - Located in the high-level radioanalytical facility
    - *Did not get a sense as to the type of XRF, as I was told that it is not a commercial instrument*

- Transmission electron microscopy (TEM)
    - Outfitted with EDS capability, but for very small samples only
    - No nuclear samples analyzed on this instrument to date
    - *Could this instrument be used for nuclear forensic analyses?*

- Scanning electron microscopy (SEM)
    - There is no SEM capability currently in the group at INP. For required analyses there are two SEM instruments at their sister facility in Astana that they sometimes utilize
    - *Addition of and practice with SEM characterizations of nuclear materials might be a relatively simple way in which INP can improve their technical nuclear forensics capability*

Also toured, but not relevant to nuclear forensic capabilities:

- INP nuclear reactor
    - 6 MW research reactor, commissioned in 1967, and re-started in 1998
    - Used for various research efforts, including:
        - Isotope production, including ^{99}Tc, ^{131}I
        - Ceramics life test
        - In-reactor Be, various grades
        - Performance of high-T gas cooled fuels
        - Irradiation work for Japanese colleagues
    - Initially used HEU fuel, but converted to LEU fuel
        - HEU spent fuel was shipped back to Russia
        - Remaining HEU fuel downblended, target isotopic composition ~19.8% ^{235}U
        - Downblending was done at Ulba, and end products will be moved back to INP
- Medical isotope production facility
    - Brand new facility, not currently operational but initial testing of various elements is now starting
    - Cyclotron (under commissioning, IBA, Belgium)
    - Will be used to produce ^{18}F, ^{201}Tl, ^{67}Ga, ^{123}I, and other isotopes, including research into very short lived isotopes.

Attachment G:
Agenda DOS Nuclear Material Inventory Management Working Group Meeting

Inventory Management System for Kazakhstan Workshop

20-21 July, 2015, Grand Sapphire Hotel, Almaty, Kazakhstan

URS Federal Services, Kazakhstan Nuclear Security Engagement, HDTRA 1-11-D-0009-0012

July 20, 2015		
Time	**Activity**	**By**
09:00 – 09:15	**Registration**	All
09:15 – 09:30	**Opening Session** *- Welcoming Remarks, Introduction/Expectation, Results of previous Workshops, April Workshop Q&A*	URS
09:30 – 10:00	Introduction of Kazakhstan major nuclear facilities (INP, NNC, UMP, Kazatomprom), CAESC Structure/IAEA reporting requirements	CAESC
10:00 – 10:45	NUCMAT Demonstration	AdSTM
10:45 – 11:00	Break	
11:00 – 11:45	NUCMAT Demonstration	AdSTM
11:45 – 12:15	NUCMAT Questions and Group Discussions	All
12:15 – 12:30	**Group Photo**	All
12:30 – 13:30	Lunch	
13:30 – 14:30	DOE Presentation – Nuclear Forensics	LLNL
14:30 – 15:30	STAR Demonstration	AMCKonsult
15:30 – 15:45	Break	
15:45 – 16:45	STAR Demonstration	AMCKonsult
16:45 – 17:15	STAR Questions and Group Discussions	All
17:15 – 17:30	Summary of Day and Closing Review of Schedule for Next Day	All

July 21, 2015		
Time	**Activity**	**By**
09:00 – 11:00	NAC Reporter Demonstration	NAC Intl.
11:00 – 11:15	Break	
11:15 – 11:45	NAC Reporter Questions and Group Discussions	All
11:45 – 12:30	Secure Communications	URS
12:30 – 13:30	Lunch	
13:30 – 14:00	Site Information Security	URS
14:00 – 14:15	Information Security	UMP
14:15 – 14:30	Information Security	NNC
14:30 – 14:45	Information Security	INP
14:45 – 15:00	Information Security	Kazatomprom
15:00 – 15:15	Information Security	CAESC
15:15 – 15:30	Break	
15:30 – 16:30	Group Discussions of NUCMAT, STAR, NAC Reporter Security Challenges Data Input Requirements IT Concerns Questionnaires Completion	URS/All
16:30 – 16:45	Summary of Workshop Closing	URS/CAESC